CHAPTER 14

CRITICAL DATA REQUIRED TO POTENTIALLY INVESTIGATE GENTING ISLAND AS HIGH-LEVEL RADIOACTIVE WASTE REPOSITORY SITE FACILITY IN INDONESIA

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14.1 INTRODUCTION

The Indonesian archipelago is one of the regions in the world that has active volcanisms. There are 129 active volcanoes in the region. The Indonesian archipelago is developing in response to the complex interaction between the southward moving Eurasian plate, the northward moving Indian-Australian plate and the westward-moving Pacific plate (Fig.14.1). The Java trench and Timor Trough represent the major area of collision between Eurasian and Indian-Australian plates. The Sorong fault indicates the area of interaction between the Pacific and Indian-Australian plate[1].

Indonesia has been actively planning to build several NPPs in the near future, despite the concerns about the-existing volcanism. The operation of these NPPs will generate waste, namely high-level radioactive wastes (HLRW). Some islands in the country have been investigated and selected as potential HLRW repository sites.

Genting island is one of these islands with a potential site for a HLRW repository site facility. A wet environment repository concept must be developed since the proposed island is an ocean-island, and the groundwater table is shallow such that the wastes will have to be emplaced in the saturated zone.

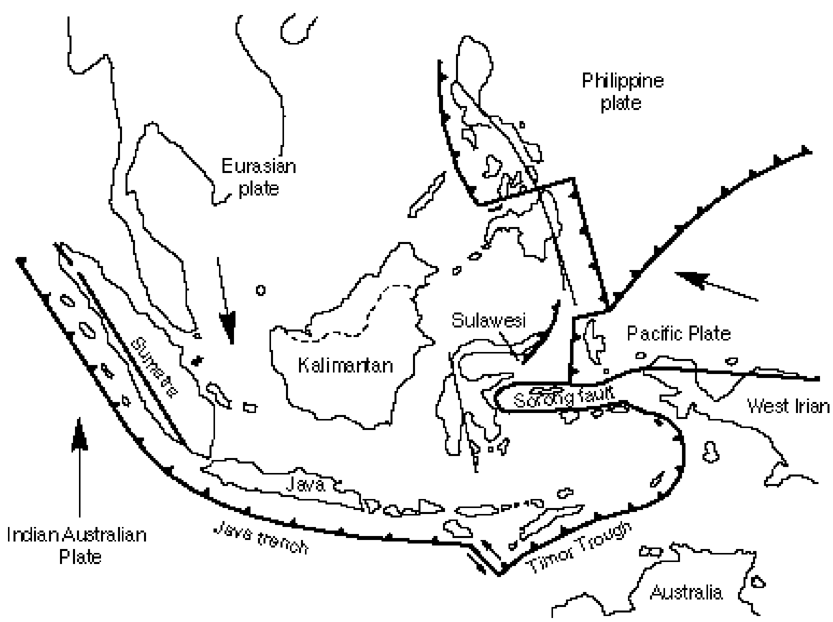

Figure 14.1. Plate boundaries in the Indonesian Archipelago.

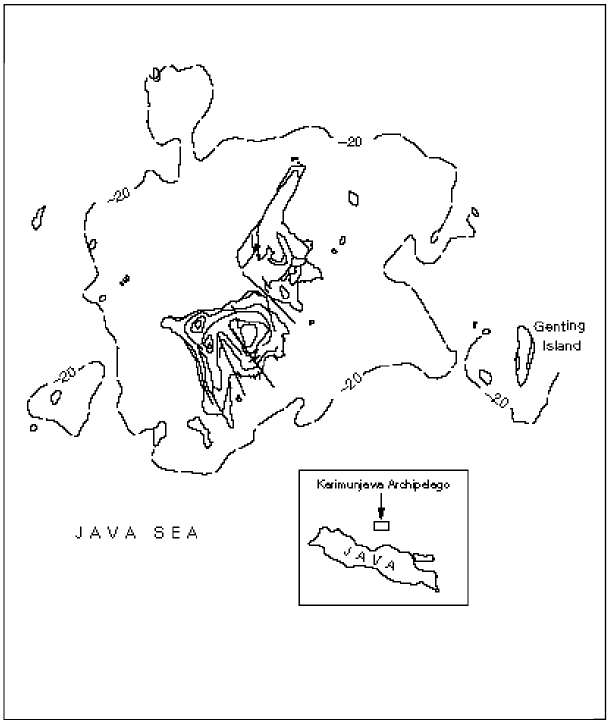

Figure 14.2. Map of Karimunjawa Archipelago showing location of Genting Island. The long-dashed line shows the location where the water depth is 20 m.

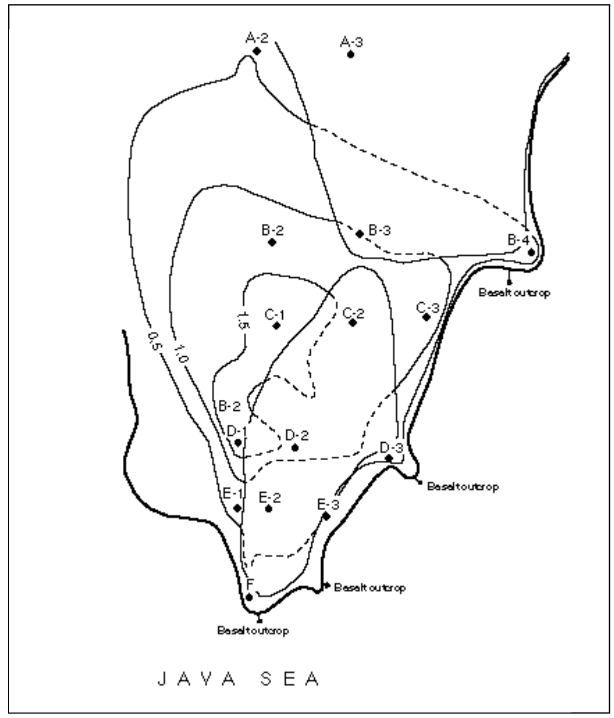

Figure 14.3. Map of groundwater levels for southern tip of Genting Island in meters above sea level. The solid lines indicate water levels that are above the land surface, and the dashed lines indicate levels that are below the land surface.

14.2 General Description of the Island

Genting island is a small island situated on the north side of Java island on the Eurasian plate (Fig. 14.2)[2]. The distance from the Java trench is approximately 400 km. This island is nearly uninhabited and there is no potential economic activity. The groundwater level at Genting Island is considered shallow, and it is influenced by changes in sea level and the rate of rainfall (Fig. 14.3)[2].

14.2.1 The Lithology of the Area

The top layer (thickness ±1.5 - 3.5 m) of soil is mainly alluvium consisting of pebble, gravel, clay, coral limestone and coarse grained rocks. Below this layer is basalt (thickness ±24 - 35 m) consisting of basaltic lava or alkaline basalt, classified as a strong rock (approximate strength is 1550.36 kg/m^2 in compression)[2]. Its strength and the interlocking of fracture blocks can limit displacement along fractures. The diffusion time of radionuclides along the rock fractures can be delayed, so that it will eventually take longer for the radionuclides to reach the accessible environment (AE). The depth to groundwater is approximately 103 m. The permeability measurements of Genting Island are shown in Table 14.1.[2]

Table 14.1. Permeability measurements for Genting Island.

Coefficient of Permeability (m/s)	Type of Rocks
1.82×10^{-6}	Soil and
1.75×10^{-6}	Basalt
1.26×10^{-7}	Basalt
5.55×10^{-6}	Basalt
4.79×10^{-6}	Basalt

The water chemistry of Genting Island is such that the concentrations of Mg^{2+}, Na^+, and Cl^- are rather high in the coastal area. The content of HCO_3^- tends to increase on the southern side of the Island. The existence of

HCO_3^- in the groundwater is due to the influence of decomposed plants and swamp materials.

The southern side of the Genting Island is primarily a volcanic cone region. The highest point of this area is 40.5 m above mean sea level, and the lowest point is about 5.0 m above mean sea level.

From geotechnical investigations, the unconfined compression strength is 360.86 kg/cm^2 . The mean value of Poissons ratio is 0.31. The mean value of the rock density is 2.797 g/cm^3, and the mean value of cohesiveness is 57.87 kg/cm^2.

14.2.2 Near-Field Conditions

In the model, pH, water contact mode, and temperature are included, where pH (at the 50 m depth in an experimental borehole), varies from 7.7 to 6.8. The average pH is 7.25, which can be considered neutral. The water contact mode, in the saturated zone can be thought of as zero velocity, which indicates diffusive transport, because Genting Island is an ocean-island[3,4,5].

14.3 Design of the Repository Site

The proposed design for the HLRWrepository site at the southern tip of Genting Island is divided into two areas or rings. The inner ring (called the high-temperature ring) that contains a group of waste packages withan areal power density of approximately 100 kw/acre, which includes 75% of the waste packages. The outer ring contains a group of waste packages with an areal power density of approximately 30 kw/acre, which includes 25% of the waste packages, and represents the ambient-temperature ring[3].

14.4 Pathway Parameters

For an ocean-island repository that is sited below the groundwater table, the most important pathway for radionuclide releases is through the groundwater. The radionuclides released through the rock will eventually reach the groundwater. In the groundwater, the radionuclides will travel in a dffusive manner to the AE. Therefore, the groundwater is expected to be the primary agent affecting the performance of the Genting Island repository. In addition to being the transport mechanism for the radionuclides, the groundwater will also corrode the waste containers when it comes in contact with the containers[6]. The shallow groundwater is assumed to exist under reducing conditions. Consequently, it is also necessary to consider solubility under reducing conditions.

In regard to gaseous flow and transport, this study suggests that C-14 will not be released in any significant quantity.[3,4,5] However a more accurate analysis should be conducted. The gas flows are driven by heat and in turn affect waste package temperatures. A coupled transient model of heat transfer and gas flow employing a relatively fine grid will be required.

The ocean dilution factor plays a very important role in reducing the concentration of radionuclides released to the AE. Their concentrations become essentially negligible when this factor is incorporated in the analyses. Therefore, it is necessary to employ a more accurate model to calculate the dilution factor[7]. However, the ocean will not be considered as the source of drinking water; only the biota in the ocean should be analyzed as the potential transport pathway in future studies[5].

14.5 Summaryand Conclusions

In addition to the problem of pathways for radionuclide releases, earthquakes play an important role in the repository integrity. When the rate of occurrence was selected to be $1x10^{-7}$, no effects are shown in the results[3]. But, when the rate of occurrence was taken to be $1x10^{-2}$, some significant effects were seen. Therefore, further study regarding seismic analyses of the site must be undertaken[8].

Understanding groundwater flow characteristics is essential when attempting to predict repository performance more accurately[9]. These characteristics are required, especially parameters of the directions of flow and the flow rate. Furthemore, if there are releases of radiation in the near-field environment, the possible degradation of the rocks in the buffer zone should also be further investigated[10].

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